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Serratus anterior plane block versus rhomboid intercostal and subserratus block for continuous analgesia in rib fractures

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Abstract

Background: Rhomboid intercostal and subserratus block (RISSB) is a novel regional analgesia procedure for hemithorax analgesia. The current study aimed to compare and evaluate the efficiency of ultrasound guided continuous RISSB versus continuous serratus anterior plane block (SAPB) in reducing the pain of rib fractures.

Patients and methods: This prospective randomized comparative blind study was conducted through one year on fifty patients who were presented by multiple rib fractures (MRF) in 2 equal groups 25 patients in SAPB group and 25 patients in RISSB.

Results: All studied groups showed no statistically significant differences as regard demographic data (age, sex, weight, height and BMI) and number of fractured ribs, VAS score, SPO2, respiratory rate, heart rate and systolic blood pressure before doing the block, 2 hours, 24 hours, 48 hours, 72 hours, 4 days, 6 days and 7 days after block ,length of stay at ICU (days), need for respiratory support, development of pneumonia, development of complications of block, total nalbuphine consumption and In-hospital mortality but SAPB group showed statistically significant decrease in respiratory rate at the 5^{th} day compared to RISSB group as following (16.22±1.17) for SAPB group and (17.47±1.77) for RISSB group.

Conclusion: From the results of this study we can conclude that both continuous serratus anterior plane block and continuous rhomboid intercostal and subserratus block seemed to be safe blocks and provide effective analgesia for unilateral multiple rib fractures.

Keywords: Rhomboid intercostal and subserratus plane block, serratus anterior plane block, rib fracture.

Introduction:

Rib fractures are found in 10% of all trauma patients and over 30% of chest trauma admissions***(Ziegler et al. 1994)***. Rib fractures may be complicated by pneumonia, pleural effusion, aspiration, acute respiratory distress syndrome (ARDS), pulmonary emboli, atelectasis or lobar collapse and death***(Unsworth et al. 2015)***. Pain management is the cornerstone for treatment of rib fractures. Effective analgesia prevents hypoventilation, enables deep breathing, adequate coughing with clearance of pulmonary secretions, and compliance with chest physiotherapy***(Wada et al. 2015)***.

Opioids were previously the mainstay of pain treatment, but with significant side effects. multi-modal analgesia is now more commonly used, which incorporates regional nerve blocks and thoracic epidural analgesia***(Karmakar et al. 2003)***.

Thoracic epidural analgesia has become the standard of care when opioid analgesia is inadequate. Hypotension related to sympathetic blockade in patients with unstable hemodynamics, concomitant thoracic spine injury, Low molecular weight heparin which may cause epidural hematoma, trauma induced coagulopathy, spinal cord injury made it contraindicated in a lot of patients so, other regional analgesia techniques have been considered***(Bulger et al. 2008)***.

Serratus anterior plane (SAP) block was approved to be a potential alternative approach for analgesia of multiple rib fractures***(Hernandez et al. 2019, Bhalla et al. 2021, Diwan et al. 2021, Mazzocchi et al. 2021, Tekşen et al. 2021)***. The rhomboid intercostal and subserratus (RISS) block is a new procedure. Its efficacy in pain control in multiple rib fractures has not been proved except by two case report.

We hypothesised that the rhomboid block may be as effective as the serratus plane block for analgesia of multiple rib fractures. The purpose of this randomized trial will be to test the effects of the rhomboid intercostal and subserratus block compared with the serratus plane block for pain of rib fractures.

Patients and methods

After approval of the Institutional Research Board (IRB), its code number is (MD.22.03.619), Faculty of Medicine, Mansoura University. This prospective randomized comparative blind study was conducted through one year on fifty patients who were presented by multiple rib fractures (MRF) and needed to be admitted at trauma intensive care unit at Mansoura University Emergency Hospital. Written informed and verbal consent was obtained from all patients prior to enrolment in this study.

Inclusion criteria: Adult patients of both gender, aged between 18-60 years with isolated thoracic trauma leading to unilateral multiple rib fractures ≤ 6 ribs.

Exclusion criteria: Patients with > 6 rib fractures, bilateral fractures, flail chest, intubated and sedated patient, associated intracranial hemorrhage which affects patient's mental status, trachea, larynx and sternum fractures, polytrauma patients with multiple fractures which affect pain score, hypersensitivity to bupivacaine, infection at the site of injection, bleeding disorders (INR≥2, platelet<100), hepatic (Child-pugh class C patients), cardiac and renal failure (on dialysis) and patients with body mass index >35.

Study design and grouping:

This study was prospective randomized study. Patients were randomly allocated by a computer-generated randomization table and group allocation was concealed in sequentially numbered and sealed opaque envelopes. Patients were randomly assigned into 2 equal groups:-

- **Group I:** Serratus anterior plane block (SAPB) in 25 patients.
- **Group II:** Rhomboid intercostal and subserratus block (RISSB) in 25 patients.

Blinding:

The study data collector was blinded to the allocated groups. The participants and the investigator who did the block were aware of intervention assignments throughout the trial.

Methods:

Patient was brought to Mansoura emergency hospital triage. The emergency physician took the patient's history (age, sex, past medical history, past surgical history, medications, allergies, family history and mode of trauma) from the patient himself or one of his relatives.

Primary survey and management of life threatening conditions was done by emergency physician. Vascular access was obtained and complete laboratory investigations as complete blood count (CBC), liver and kidney function tests, coagulation

profile (prothrombin time and activity and INR) and arterial blood gases were done for all patients.

Cervical X ray, chest X ray, brain CT (if there was trauma to the head or decrease in GCS) and Focused Abdominal Sonography for Trauma (FAST) were done for all patients.

Emergency physician wrote his report and findings and informed the intensivist and the patient was transferred to trauma intensive care unit.

Patient was admitted to trauma intensive care unit. Standard monitoring equipment were attached to the patient (five leads electrocardiogram (ECG), pulse oximetry and non-invasive blood pressure). General examination of the patients was done by intensivist including mental status (glascocoma score), vital signs (blood pressure, heart rate, respiratory rate and body temperature), cardiovascular, abdominal and skeletal examination.

Focused examination of the chest was done. Inspection of chest wall was done for detection of hematoma, ecchymosis, respiratory distress, unilateral chest wall movement as in pneumothorax and paradoxical chest wall movement as in flail chest. Palpation of the chest wall was done for detection of tenderness and chest crepitus might be present in case of subcutaneous emphysema. Chest auscultation was done for detection of diminished air entry or crepitation or secretion as rib fracture might be associated with pneumothorax, hemothorax or lung contusion. Laboratory investigations and radiology scan reviewed by the intensivist.

After stabilization of general conditions, any patient intubated, his mental status was affected, presented with fractures other than rib fracture or had any exclusion criteria the procedure was aborted. Other patients were informed and verbal and written consent was obtained from them after explanation of the procedure, its benefits and its side effects.

All patients received iv 1gm paracetamol every 8 hours and 30mg ketolac once after admission to ICU if there is no contraindications.

Before doing the block, Patients were informed that degree of pain would be measured by visual analogue score by using a ruler. VAS have been recommended: no pain (0), mild pain (1-3), moderate pain (4-6), severe pain (7-9) and worst pain possible (10)

- **Group I (serratus anterior plane block):**

The technique of this block was done as described by Blanco, et al. The patient was in the supine position with abducted arm. A high frequency linear ultrasound probe (GE healthcare logiQ e MANGO 150L-19AK-LE) set between 6 and 13 MHz was used. The probe was placed in the sagittal plane and identify the fifth rib in the mid-axillary line. Latissimus dorsi and serratus anterior muscles were easily identifiable overlying the fifth rib. The plane was found between a depth of 1-2 cm from the skin, with the thoracodorsal artery passing in the superficial plane to serratus anterior.

After sterilization and local anaesthetic infiltration, an 18 Gauge Tuohy needle was used. The needle was inserted in plane superficial to the serratus anterior muscle. Bupivacaine was injected and good spread between latissimus dorsi and the serratus muscle was confirmed.

A bolus of 0.3 mL/kg (1.5 mg/kg) bupivacaine 0.5% was injected then a catheter was inserted 2-3 cm into the space, tunnel, and secure in place. Correct catheter placement was confirmed by demonstrating further bupivacaine spread under ultrasound visualization. Bupivacaine 0.25% was infused (weight dependant) at 0.1 mL/kg/h via an elastomeric pump, and was kept running for up to 7 days if no signs of infection and we ensured not to exceed maximum dose.

- **Group II (rhomboid intercostal and subserratus block):**

The technique was done as described by Elsharkawy, et al. The patient was placed in the sitting position or lateral decubitus position with abducted and internally rotated arm to move the inferior angle of the scapula laterally. A linear ultrasound (GE healthcare logiQ e MANGO 150L-19AK-LE) transducer (6-13 MHz) was placed in the sagittal plane medial to the medial border of the scapula with the orientation marker directed cranially. The transducer was then rotated so the cranial end will be directed slightly medially and the caudal end laterally to produce an oblique sagittal view (paramedian sagittal oblique) approximately 1 to 2 cm medial to the medial scapular border.

The following structures were identified from superficial to deep: trapezius muscle, rhomboid major muscle, intercostal muscles between ribs, pleura, and lung. The tissue plane between the rhomboid major and intercostal muscles was identified. An 18 Gauge Tuohy needle was advanced in plane from a supero-

medial to infero-lateral direction, through the trapezius and rhomboid major muscles.

Next, to identify the subserratus plane, the transducer was moved caudally and laterally, distal to the inferior angle of the scapula behind the posterior axillary line. Tissue layers were identified from superficial to deep: latissimus dorsi, serratus anterior, intercostal muscles between ribs, pleura, and lung. The needle was inserted at the same skin entry site as that was used for the rhomboid intercostal injection but was directed caudally and laterally beyond the inferior angle of the scapula.

Bolus of 0.3ml/kg (1.5mg/kg) bupivacaine 0.5% was injected. Half of it injected in the fascial plane between the rhomboid major muscle and the intercostal muscles and the other half injected in the tissue plane between the serratus anterior and external intercostal muscle.

The skin entry point for the first injection was at the T5-T6 level just medial to the scapula. Two landmarks verified identification of the T5-T6 level either counting down from the C7 spinous process or identifying the medial part of the spine of the scapula at the T3 level.

Then a catheter was inserted 2–3 cm into the space, tunnel, and secure in place. Correct catheter placement was confirmed by demonstrating further bupivacaine spread under ultrasound visualization. Bupivacaine 0.25% was infused at 0.1 mL/kg/h via an elastomeric pump, and was kept running for up to 7 days if no signs of infection and we ensured not to exceed maximum dose.

Close monitoring of the patient was done due to fear of local anaesthetic toxicity.

After doing the block; the patient was covered by medical gown and the catheter was passed from the neck of the gown for all patients in the two groups to make the data collecter blind unaware of intervention assignments throughout the trial and routine chest x-ray was done for exclusion of pneumothorax.

If there was moderate to severe pain after doing the block, nalbuphine would be titrated intravenously and the total nalbuphine consumption was measured.

Collected data:

Basal hemodynamics (heart rate, blood pressure), respiratory rate and saturation by pulse oximeter and basal visual analogue score were recorded before doing the block. Patient's weight, height and body mass index (BMI) were measured.

We also recorded visual analogue score, hemodynamics (heart rate, blood pressure), respiratory rate and saturation by pulse oximeter 2 hours , 24 hour, 48 hour, 72 hour after doing the block and every 24 hour until the catheter removed.

Statistical analysis

IBM's SPSS statistics (Statistical Package for the Social Sciences) for windows (version 25) was used for statistical analysis of the collected data. Shapiro-Wilk test was used to check the normality of the data distribution. Normally distributed continuous variables was expressed as mean ± SD while categorical variables and the abnormally distributed continuous ones were expressed as median and inter-quartile range or number and percentage (as appropriate). Student t test and Mann-Whitney were used for normally and abnormally distributed continuous data respectively. Chi square test was used for categorical data using the crosstabs function. All tests were conducted with 95% confidence interval. If needed, bivariate correlations were assessed using Pearson's or Spearman's correlation coefficient depending on the nature of data. P (probability) value < 0.05 was considered statistically significant.

Results

Fifty patients were randomized for peripheral nerve block either by serratus anterior plane block **(SAPB)** or rhomboid intercostal and subserratus block **(RISSB)** after thoracic trauma that lead to unilateral rib fracture.

All studied groups showed no statistically significant differences as regard demographic data (age, sex, weight, height and BMI) and number of fractured ribs **(table1)**.

All studied groups showed no statistically significant differences as regard VAS score, SPO2, respiratory rate, heart rate and systolic blood pressure before doing the block, 2 hours after block, 24 hours after block, 48 hours after block, 72 hours after block, 4 days after block, 6 days after block and 7 days after block but SAPB group showed statistically significant decrease in respiratory rate at the 5^{th} day compared to RISSB group as following (16.22±1.17) for SAPB group and (17.47±1.77) for RISSB group **(table 2,3,4,5,6).**

All studied groups showed no statistically significant differences as regard length of stay at ICU (days),

need for respiratory support, development of pneumonia, development of complications of block, total nalbuphine consumption and In-hospital mortality **(table7).**

	Serratus anterior plane block (SAPB) N=25	Rhomboid intercostal and subserratus block (RISSB) N=25	Test of significance
Age /years (Mean ±SD)	42.72±10.27	44.48±10.09	p=0.544
Sex N(%) F M	5(20.0) 20(80.0)	8(32.0) 17(68.0)	P=0.333
Weight(kg)(Mean ±SD)	81.0±7.14	80.64±6.68	p=0.855
Height (Cm)(Mean ±SD)	174.84±3.48	174.60±3.64	p=0.812
BMI(kg/m²)(Mean ±SD)	26.54±2.30	26.46±2.12	p=0.904
Number of fractured ribs	4(3-6)	4(3-6)	P=0.935

P value is significant when it is ≤ 0.05, M: male gender, F: female gender, BMI: body mass index, N: number.

Table (1): comparison of demographic and clinical characteristics between studied groups, data are expressed as mean and standard deviation or numbers (percentage).

Spo2	Serratus anterior plane block (SAPB) N=25	Rhomboid intercostal and subserratus block (RISSB) N=25	Test of significance
before doing the block	93.60±2.43	94.40±2.06	p=0.216
2 H after block	94.88±1.76	95.52±1.64	p=0.190
24 H after block	96.0±1.38	96.0±1.50	p=1.0
48H after block	96.36±1.22	96.32±1.70	p=0.924
72 H after block	96.60±1.12	96.56±1.39	p=0.911
4 days after block	96.87±1.14	96.65±1.72	p=0.616
5 days after block	96.89±0.58	97.07±1.33	p=0.604
6 days after block	97.25±0.50	96.90±0.57	p=0.305
7 days after block	97.0±0.0	97.0±0.0	p=1.0

P value is significant when it is ≤ 0.05, SPO2: oxygen saturation by pulse oximetry, H: hour.

Table (3): comparison of SPO2 between studied groups, data are expressed as mean and standard deviation.

VAS	Serratus anterior plane block (SAPB) N=25	Rhomboid intercostal and subserratus block (RISSB) N=25	Test of significance
before doing the block	8.52±0.96	8.52±1.0	P=0.976
2 H after block	2.92±0.81	2.96±0.79	P=0.779
24 H after block	2.56±0.82	2.64±0.81	P=0.792
48H after block	2.04±0.79	2.12±0.78	P=0.695
72 H after block	1.76±0.72	1.72±0.79	P=0.915
4 days after block	1.39±0.49	1.43±0.59	P=0.908
5 days after block	1.33±0.59	1.33±0.62	P=0.963
6 days after block	1.0±0.0	1.0±0.0	P=1.0
7 days after block	1.0±0.0	1.0±0.0	P=1.0

P value is significant when it is ≤ 0.05, VAS: visual analogue score.

Table (2): comparison of VAS score between studied groups, data

SBP	Serratus anterior plane block (SAPB) N=25	Rhomboid intercostal and subserratus block (RISSB) N=25	Test of significance
before	144.76±12.44	141.52±12.97	p=0.372
2 H	130.88±7.66	132.12±11.59	p=0.658
24 H	128.44±8.73	131.32±12.86	p=0.359
48H	126.52±7.15	128.96±10.39	p=0.338
72 H	126.08±4.80	128.0±10.0	p=0.391
4 days	128.74±8.25	129.30±6.98	p=0.803
5 days	129.67±5.85	128.73±5.49	p=0.642
6 days	129.60±5.85	132.64±5.14	p=0.311
7 days	131.0±2.83	135.67±3.06	p=0.185

P value is significant when it is ≤ 0.05, SBP: systolic blood pressure, H: hour.

Table (6): comparison of systolic blood pressure between studied groups, data are expressed as mean and standard deviation.

RR	Serratus anterior plane block (SAPB) N=25	Rhomboid intercostal and subserratus block (RISSB) N=25	Test of significance
before	**30.64±3.55**	**30.16±4.47**	**p=0.676**
2 H	**23.52±1.76**	**23.92±2.27**	**p=0.490**
24 H	**18.24±2.26**	**18.80±2.71**	**p=0.431**
48H	**17.12±1.74**	**18.08±2.41**	**p=0.113**
72 H	**15.60±1.73**	**16.40±2.45**	**p=0.189**
4 days	**16.52±1.62**	**16.87±1.68**	**p=0.479**
5 days	**16.22±1.17**	**17.47±1.77**	**p=0.02***
6 days	**16.40±0.89**	**16.36±1.21**	**p=0.953**
7 days	**16.0±0.0**	**16.0±0.0**	**p=1.0**

P value is significant when it is ≤ 0.05, RR: respiratory rate, H: hour, *statistically significant.

Table (4): comparison of respiratory rate between studied groups, data are expressed as mean and standard deviation.

HR	Serratus anterior plane block (SAPB) N=25	Rhomboid intercostal and subserratus block (RISSB) N=25	Test of significance
before	106.20±7.36	104.96±6.04	p=0.518
2 H	94.24±5.74	93.36±4.79	p=0.559
24 H	87.52±7.51	85.84±7.49	p=0.432
48H	84.04±8.56	81.80±8.19	p=0.349
72 H	81.08±7.66	79.72±8.28	p=0.550
4 days	80.35±5.92	77.82±6.58	p=0.179
5 days	79.88±5.09	76.60±7.52	p=0.146
6 days	80.20±7.66	74.45±7.94	p=0.197
7 days	78.50±0.71	80.33±6.51	p=0.731

P value is significant when it is ≤ 0.05, HR: heart rate, H: hour.

Table (5): comparison of heart rate between studied groups, data are expressed as mean and standard deviation.

	Serratus anterior plane block (SAPB) N=25	Rhomboid intercostal and subserratus block (RISSB) N=25	Test of significance
Length of stay at ICU(days)	5.92±0.99	6.08±1.22	P=0.637
Need for respiratory support **+VE** **-VE**	 5(20.0) 20(80.0)	 4(16.0) 21(84.0)	P=0.713
Development of pneumonia	0	0	…….
Development of complications of block	0	0	…….
Total nalbuphine consumption	17.60±3.83	18.46±3.63	P=0.325
In-hospital mortality	0	0	

P value is significant when it is ≤ 0.05, +VE: non invasive ventilation is needed, -VE: no need for non invasive ventilation.

Table (7): comparison of complications between studied groups, data are expressed as mean±SD , median (range) and number (%).

Discussion

Rib fractures are very common which caused by blunt thoracic trauma with road traffic collisions and penetrating injuries***(Pressley et al. 2012)***. It is associated with significant morbidity and mortality rates which caused by hypoventilation due to pain, impaired gas exchange in damaged lung, and altered breathing mechanics**(Unsworth et al. 2015)**. Pain reduces the tidal volume which may lead to atelectasis. This can further lead to retention of pulmonary secretions so it may be complicated by pneumonia, pleural effusion, aspiration, acute respiratory distress syndrome (ARDS), pulmonary emboli, atelectasis or lobar collapse and death***(Wada et al. 2015)***.

Pain management is the cornerstone for treatment of rib fractures. Effective analgesia prevents hypoventilation, enables deep breathing, adequate coughing with clearance of pulmonary secretions, and compliance with chest physiotherapy and this will reduce secondary pulmonary complications. Opioids were previously the mainstay of pain treatment, but with significant side effects including depressed cough reflex, emesis, prolonged length of hospital stay (LOS) and delirium***(Karmakar et al. 2003)***; multi-modal analgesia is now more commonly used, which incorporates regional nerve blocks and thoracic epidural analgesia.

Thoracic epidural analgesia has become the standard of care when opioid analgesia is inadequate. Hypotension related to sympathetic blockade in patients with unstable hemodynamics, concomitant thoracic spine injury, Low molecular weight heparin which may cause epidural hematoma, trauma induced coagulopathy, spinal cord injury made it contraindicated in a lot of patients so, other regional analgesia techniques have been considered***(Bulger et al. 2008)***.

SAPB efficacy was evaluated for thoracic analgesia for control post thoracotomy pain***(Khalil et al. 2017, Semyonov et al. 2019, Elsabeeny et al. 2021)***, thoracoscopic pain***(Park et al. 2018, Gao et al. 2022)***, post mastectomy pain***(Gupta et al. 2017, Xiao et al. 2021)*** and rib fracture pain***(Hernandez et al. 2019, Bhalla et al. 2021, Diwan et al. 2021, Mazzocchi et al. 2021, Tekşen et al. 2021)***. RISSB was evaluated for hemithorax analgesia for control of post thoracotomy pain***(Kozanhan et al. 2022)***, thoracoscopic pain***(Deng et al. 2021, Deng et al. 2022, Zhang et al. 2022, Elhouty et al. 2023)*** and post mastectomy pain***(Altıparmak et al. 2020, Ciftci et al. 2021, Jiang et al. 2021)*** but there are no studies done for evaluation of its effect in management of rib fracture pain.

Our study aimed to compare and evaluate the efficiency of ultrasound guided continuous RISSB versus continuous SAPB in reducing the pain of rib fractures. We hypothesized that RISSB may be as effective as the SAPB for analgesia of multiple rib fractures.

This study comprised 50 patients with unilateral rib fracture. The study was carried out at trauma intensive care unit at Mansoura University Emergency Hospital for 12 months from September 2022 to September 2023.

There were 85 patients assessed for eligibility. 35 patients were excluded (5 patients were associated with other fractures which affected pain score, 8 patients were bilateral rib fractures, 10 patient were above 60 years, 2 patients were flail chest, 7 patients were aborted after doing the block due to severe respiratory distress which needed intubation, mechanical ventilation and sedation and 2 patients had BMI> 35 and 1 patient had coagulopathy with INR=2.6. 50 patients were randomized for doing our study. 25 patients were allocated in SAPB group. The other 25 patients were allocated in RISSB group.

Regarding demographic and clinical parameters, there were no statistically significant differences between both groups as regard age, sex, weight, height, BMI and number of fractured ribs. These outcomes demonstrated that both groups were comparable and such data were not interfering with the results.

The age of most of patients (64%) were between 40 years and 60 years, this was explained by decrease flexibility and increase fragility of ribs with progression of age***(Sirmali et al. 2003, Sharma et al. 2008)***.

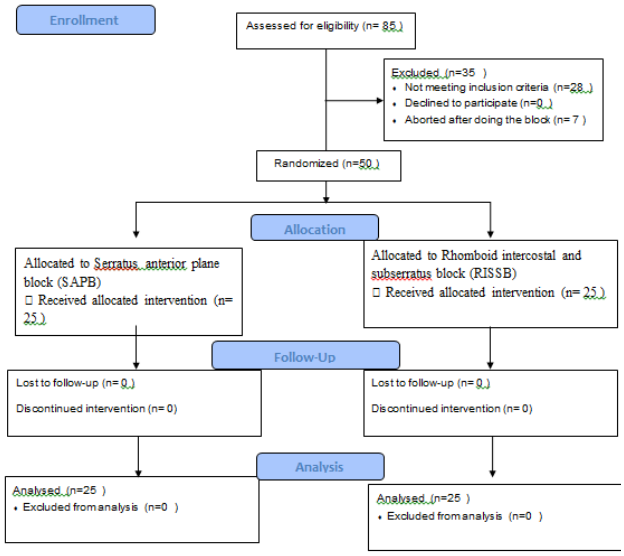

Figure 1:CONSORT flow chart showing study design.

Although number of fractured ribs included in our study was ≤6 ribs, all patients admitted to ICU had ≥3 rib fractured, this may be explained by all patient with one to two fractured ribs had mild pain which can be treated with simple analgesics in the department or at home & increasing the number of fractured ribs has been correlated with severity of trauma, pain, morbidity and mortality***(Majercik et al. 2017)***.

The present study demonstrated that: VAS, heart rate, blood pressure, SPO2 and respiratory rate before doing the block and at 2, 24, 48, 72, 4 days, 5 days, 6 days and 7 days after doing the block demonstrated insignificant differences between both studied groups except SAPB group showed statistically significant decrease in respiratory rate at the 5th day compared to RISSB group as following (16.22±1.17) for SAPB group and (17.47±1.77) for RISSB group which was statistically significant but clinically insignificant.

Several studies were done about the effect of serratus anterior plane block in rib fracture, **Tekşen et al. 2021** conducted on Sixty patients in the study had to be between the ages of 18–90 years with rib fracture pain (numerical rating scale [NRS] score ≥ 4), Primary outcome was total tramadol consumption in 24 h. Secondary outcomes were NRS scores (after Patient Controlled Analgesia (PCA) application 30 min, first, second, 4th, 6th, 12th, 24th hour), peripheral oxygen saturation (first and 24th hour after PCA application), chronic pain and complications. In this study, serratus anterior plane block group had lesser analgesic consumption, lower pain scores, and lesser chronic pain compared to control group***(Tekşen et al. 2021)***.

Lundén et al. 2023, In this study, 59 patients were included with unilateral MRFs and a numerical rating scale (NRS) pain score ≥4 at rest or upon movement. Patients were randomised to receive a US-guided SAPB or continuous infusion epidural analgesia (EA) with 2 mg/mL ropivacaine. This study showed a significant reduction (≥2) in NRS for both groups; however, EA associated with a greater reduction in NRS upon movement after block initiation. The mean reduction in NRS upon movement within 1 h was 3 (1.8, $p < .01$) in the SAPB group versus 4.7 (2.4, $p < .01$) in the EA group. No significant difference between groups in pain scores on Days 1 and 2 following the block was founded. In the EA group, FEV1% increase in the first 12 h from baseline. Finally, PCA oxycodone consumption did not differ between groups***(Lundén et al. 2023)***.

Hernandez et al. 2019 is a retrospective study conducted on Thirty-four patients in the study had to be above the age of 17 years with three or more consecutive rib fractures, who underwent either unilateral or bilateral ultrasound-guided SAPB for pain control, Data analyzed included demographics, number of ribs fractured, pain score as assessed by numeric rating scale (NRS), respiratory rate (RR), oxygen saturation (SpO2), and IS volumes Pre- and post-SPB data were collected. In this study, SAPB was effective in reducing pain scores 0.5–4 hours after injection of local anesthetic (NRS score decreased from a median of 7 to 3 after block onset), IS volumes at 4, 24, and 48 hours improved significantly, Median values for RR decreased significantly from 24.5 to 16 breaths per minute, SpO2 improved from a median value of 96% to 99% within 24 hours after SAPB***(Hernandez et al. 2019)***.

Concerning block-related intraoperative complications, the current study demonstrated that there weren't complications (hematoma, infection at site of catheter insertion, pneumothorax, hemothorax and local anesthetic toxicity) for both studied groups.

Concering total nalbuphine consumption, The current study demonstrated that low doses of nalbuphine were used for breakthrough pain and there was no statistically significant difference between both studied groups. This explained by

several studies in which dose of opioid was decreased in case of regional analgesia.

Concering development of pneumonia, The current study demonstrated that there was no cases who developed pneumonia in both studied groups. This may be explained by an effective analgesia promptly prevents hypoventilation, enables deep breathing, adequate coughing with clearance of pulmonary secretions, and compliance with chest physiotherapy in patients who sustain MRFs. Overall, this reduced secondary pulmonary complications, including atelectasis and pneumonia***(Karmakar et al. 2003, Malchow et al. 2008)***.

Concering need for respiratory support, The current study demonstrated that 5 patients in SAPB group and 4 patients in RISSB group needed non invasive ventilation. The common characterstics between these patients were presence of 5 to 6 ribs fractures with moderate to severe lung contusion and all aged above 45 year old. 7 of them (4 in SABP group and 3 in RISSB group) were heavy smoker and auscultation of the chest reveals wheezy chest. This explained that the cause for need for respiratory support was not poor analgesia but due to poor chest conditions.

Concering length of stay at ICU, The current study demonstrated that there was no statistically significant difference between 2 studied groups. Median number of days for ICU stay was 6 days. Longer ICU stay (up to 8 days) needed for patients with 5 to 6 fractured ribs, higher rate of lung contusions and patients required respiratory support. This explained by, **Abdelwahed et al. 2022**, In this study of major trauma patients with multiple rib fractures with high severity scores, and admitted to a tertiary-referral ICU, the ICU LOS was similar to national and international centres. Nonmodifiable factors such as a high Injury Severity Score (ISS) and APACHE-II scores, a higher number of rib fractures, and the presence of lung contusions and flail chest segments were associated with an ICU LOS of 7 or more days. Modifiable factors such as the need for any type of respiratory support, surgical rib stabilization, and tracheostomies were also associated with a longer ICU LOS***(Abdelwahed et al. 2022)***.

Limitations

The VAS score is a subjective method for the assessment of pain and needs patients to be intelligent and cooperative, so it is not an accurate method for assessment, we didn't compare VAS score in deep breathing, walking and during cough, single blind study in which only the data collector was blinded but the patient and the investigator weren't blinded, small sample size and we didn't stipulate site of rib fracture (posterior or lateral) to be fixed for comparing the analgesic effect of SAPB and RISSB.

Recommendations

We recommend to compare the effect of both blocks in larger sample size ,to compare the effect of both blocks by respiratory function tests as FEV1, FVC, to fix the site of rib fracture when comparing between these two blocks and to do the block at emergency room after doing the primary survey to avoid administration of any analgesics which may do misinterpretation.

Conclusion

From the results of this study we can conclude that both continuous serratus anterior plane block and continuous rhomboid intercostal and subserratus block seemed to be safe blocks and provide effective analgesia for unilateral multiple rib fractures.

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